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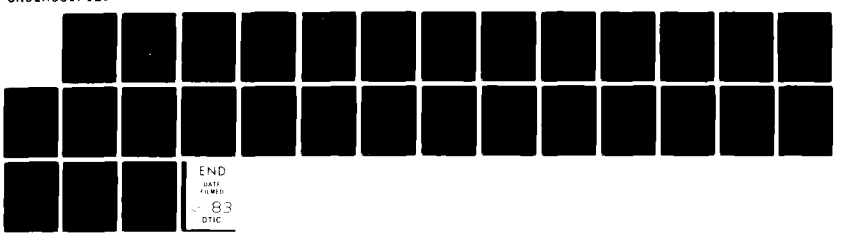

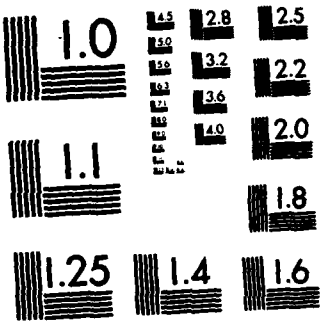

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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the Scientific Literature) may prove of value to American scientists by calling attention to current developments and to institutions and individuals engaged in these scientific efforts.

The articles are written primarily by members of the staff of ONRL and occasionally articles are prepared by, or in cooperation with members of the

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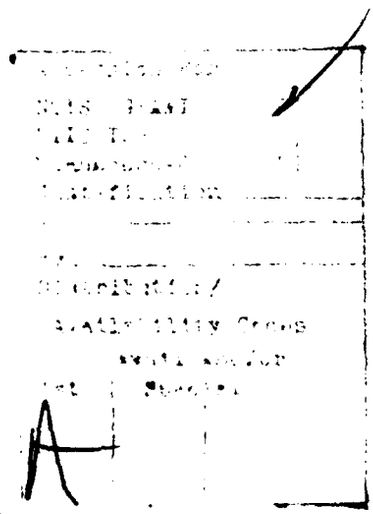
scientific staffs of the United States Air Force's European Office of Aerospace Research and Development and the United States Army Research and Standardization Group. Articles are also contributed by visiting Stateside scientists.



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BEHAVIORAL SCIENCES

CONSISTENCY OF URINARY CATECHOLAMINE EXCRETION

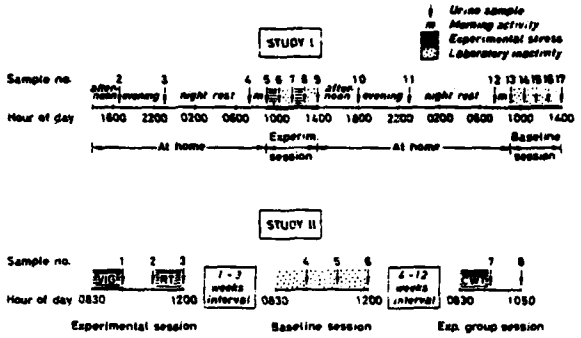
When individuals are placed under performance stress, various endocrinological changes can be observed. Among the most investigated measures are urinary catecholamines, which have been studied for a number of years at the University of Stockholm Department of Psychology. Previous work indicated that group response patterns might be consistent over some months and that individual excretion levels were often stable across different situations on the same day. Some recent parametric studies at the university have not only looked at the general consistency of excretion but have also explored the stability of person-situation interaction and change-score variances. Lennart Forsman was the principal investigator in the work described here; other Stockholm researchers in the area were David Magnusson and M. Frankenhauser.

The Stockholm project distinguishes between two types of response consistency. Absolute consistency means that an individual's score does not vary much from one situation to another; the usual descriptive statistics might give a satisfactory estimate of this kind of consistency. Relative consistency has to do with the standing of an individual in some reference sample of data; situations such as fatigue or the stress of a highly speeded task might drive nearly all response levels up, but if an individual's ranking in the group remained about the same, then relative consistency could be claimed. Correlations across occasions could be taken as indicators of relative consistency.

Forsman had 44 subjects, all of whom were young, healthy, male students of psychology or medicine at Stockholm. Because many urine samples were to be taken, all subjects were first given an introductory individual session at the laboratory, where they were carefully trained to take and to preserve specimens in a very precise manner. After sufficient walk-throughs, the study plan was described; it was split into Study I and Study II, with the urine-collection schedule shown in the figure.

Study I ran for 3 consecutive days with a total of 17 urine samples: 6 at home, 11 in the laboratory. Between 1000 and 1400 hours each day, there were alternating hours of experimental stress (mental tasks) and inactivity (reading magazines in an armchair). There were five baseline samples in the last afternoon.

In Study II 8 urine samples were collected, all in the laboratory. Subjects were tested individually on a vigilance task and a reaction-time task; after an interval of 1 to 3 weeks, a 3-hour baseline session was administered, resembling the Study I baseline measurements.



Time schedule for the collection of urine samples in Study I and Study II.

Some 4 to 12 weeks later, there was a final group session in which the subjects took the Color Word Test (CWT), which is a version of Stroop color naming. The chemical procedures measured free adrenaline and noradrenaline by fluorophotometric techniques.

With so many measurements and potential comparisons, only a few of the results can be reviewed here. There was a strong difference between adrenaline secretion in the experimental-stress conditions and the inactivity conditions in Study I. In Study II, all three experimental tasks produced adrenaline levels (pmol/min) that were significantly different from baseline and that were sometimes twice as high as baseline. Noradrenaline changes were generally less marked; indeed, the highest mean noradrenaline scores were recorded for the Study I "home afternoon" and Study II "inactivity" periods.

To study the relationships among situations and time intervals, Forsman computed Pearson correlations across subjects for the complete data set. Hierarchical cluster analysis was then applied to the correlation matrix; the technique produces clusters of variables and can be used in an exploratory fashion. Thus, at the lowest level each situation is a separate cluster or variable; as the analysis proceeds, little clusters merge until finally there is only one massive cluster. There are formal methods for deciding when clusters are optimally connected or when they are compact. (A compact cluster, for example, would exhibit some of the same properties that are found in simple-structure factors.)

For adrenaline scores, there were several interpretable clusters. "Laboratory and morning" measurements hung together rather well, and the baseline and inactivity determinations stayed together about as would be expected. There were also some indications that an activity cluster (mornings and experimental stress) could stand apart from the baseline-inactivity set of situations.

Because noradrenaline was less sensitive and probably less reliable, the tentative clusters that emerged on that variable were less clearly interpretable. Forsman believes this may be explained by the hypothesis that adrenaline secretion is more sensitive to general activity level.

Analyses of variance were run to estimate the percentage of variance due to individuals, situations, and individual-X-situation interaction. For adrenaline, differences between situations (say, between laboratory inactivity and laboratory experimental stress) were always significant; this was true even when the conditions did not include all situations. Again, noradrenaline score differences were less pronounced. When situations were similar, the differences between individuals were by far the largest sources of variance. Subject-situation interaction was greatest in the evening and night situations at home. For the baseline-vs-activity comparisons on adrenaline, it turned out that nearly 75% of baseline variance was due to individual differences, but when activity scores were analyzed, interaction and situational components were nearly equal to the contribution of subject variance.

When a suitable baseline is established, difference or change scores can be calculated; an example would be the change from baseline as a result of task stress, or a recovery back toward baseline after exposure to a demanding experience. Correlations between log first-stress scores (as a percentage of inactivity) and log second-stress scores were in the 0.54 range for adrenaline. The correlations were highest when the stimulus input was not under the control of the subject, such as in the vigilance or high-frequency CWT color naming phases; the correlation of change and baseline was an astonishing 0.81 for adrenaline under the latter two tests.

The main finding is that relative consistency is very high for both urinary adrenaline and noradrenaline measurements. Inter-subject variance predominates during baseline and inactive periods; when task stress is imposed, interactions and situational variances have important impacts on results. Log transforms of simple difference scores are stable enough to study catecholamine changes.

The Stockholm work continues the movement toward a system of behavioral measurement that will combine physiological excretion parameters with task and personality variables. There is no reason to think that a single best indicator will emerge for general use; rather, a weighted series of measurements over assorted situations and time intervals will be required to capture the performance variance.

Nicholas A. Bond, Jr.

ONR London

MAN-COMPUTER DIALOG DESIGN

The domain of man-computer interaction is experiencing a boom just now. On the ergonomics side, there are several compilations that approach handbook status, and manufacturers are using ergonomic research for their new terminals and systems. Hardware configurations improve all the time; the day approaches when fast animation, sound output, voice input, and truly flexible software will be incorporated in nearly all systems. All these capabilities are dazzling, but, according to some analysts, there is the haunting possibility that system designers are still avoiding some of the most basic problems of man-computer dialog. The problems, it appears, reside mostly in the rather vaguely defined interface domain. A useful review of the situation was given in March 1982 by J. Nievergelt (Institut für Informatik, Zurich, Switzerland) in a paper at the International Zurich Seminar on Digital Communications.

There are many horror stories in the computer-use folklore; they often recount the irretrievable loss of information. Nievergelt tells of an experience he had when a computer operator grabbed the "nearest disk pack" to run a test routine on a suspect disk drive. When the drive malfunctioned, the disk directory was destroyed. To effect a partial remedy, the operator spent some days writing a special scavenger program. (A scavenger program is one that searches a disk and tries to segregate file headings.) By means of the scavenger and a lot of manual reconstruction, much of the lost file was reconstituted. In fact, the scavenger routine became a handy tool for the programmers. As Nievergelt observes, the trouble could have been avoided by using a scratch disk for hardware testing and by keeping backup files rigorously up to date. But his point is that the average person does not maintain a backup car in the garage or keep scratch records to test his record player before using it. If computers are to be promoted as consumer products, they must be designed to forgive ordinary consumer mistakes. There should be few surprises.

Perhaps the greatest problem facing the computer operator is insufficient state information. In a typical case, the user is working in edit mode and has to leave the terminal for some minutes. When he returns, the screen looks the same, but the operator may have forgotten such things as what file he was working on or which mode was operative when he left. Some state information may be available if the system programmer has thought to provide it. In addition, although a user can do experiments such as exiting from one mode in order to inspect something in the file structure, the trials and probes may yield unpleasant surprises. Nievergelt notes that such problems can be avoided almost totally if the system designer follows a simple principle:

> **The user must be able AT ALL TIMES to determine conveniently the entire state of the system WITHOUT CHANGING THE STATE.**

To implement this innocuous-sounding but far-reaching principle, there should be explicit provision for the user to discover his current data environment, his command environment, and his recent "trail" of activities during a session.

Regarding the command language, Nievergelt believes that present interactive systems may have too many commands. Taking the popular UCSD Pascal as an example, he finds dozens of commands (28 in the editor alone). An effective user of such a system has to memorize all the commands. (Surprisingly, it appears that few psychological studies have been done on the memorization or on the utilization of computer command languages.) As to whether this large number of commands is really necessary, Nievergelt's answer is that, if the general dialog commands are shared by all the interactive utilities performed by the system, only about a dozen general commands are really required. To achieve this, of course, great attention must be paid to keeping the activation and meaning of the commands the same, regardless of the type of reference objects or bits of data being processed.

On the response side, a prevailing difficulty is the lack of feedback to the user; this complaint is often heard from the nonexpert, who may be unsure of just what to do next, when the machine "just sits there." Nievergelt has a psychological explanation for the problem: the systems programmer who designs the man-machine dialog tends to identify himself with the machine, because he must always plan how the machine will deliver something on the screen, but he doesn't naturally put himself in the position of a relatively passive or naive "waiter" on the other side of the screen. Automatic feedback can be envisioned at several levels. Thus, the system might indicate that a parameter or a command has been recognized or that a command is now being processed. Good practical displays of such feedback may require ergonomics work that has not yet been done. For example, mnemonic support for command and response symbols has not been investigated systematically.

A clearly recorded user's trail through a man-computer dialog may be very useful, yet few systems provide it in an easily usable replay form. As one tool, Nievergelt proposes a universal UNDO command, which is always able to cancel the last command executed. He finds the standard "are you sure?" query to be especially irritating, as it often happens that an operator is quite sure at the time that any action is the right thing to do; only later is the logical error realized.

Little errors in dialog design can accumulate. If a machine doesn't say what mode it is in at any given moment, the operator can go on believing it should respond in a certain way, but the machine never will satisfy the operator if he is mistaken about the mode. Again, if a command structure is very tight and cannot accept misspelled words, it may be frustrating to a naive user, who keeps asking the computer for something but receives only an unintelligible "syntax error" message back. In the same way, arbitrary and nonintuitive command practices for transferring or storing data may prove to be far less manageable to users than they are to system experts.

Colloquial dialog is often superficially attractive and is fun to write, but it is often counterproductive because it suggests to the user that the machine can actually respond to colloquial user requests and responses. If the machine breezily prints out "Would you like an opportunity to practice?" it may not be able to accept a conversational answer from the user, such as, "I don't know, give me some options". Giving the user an option menu may be far better than a partial colloquialism. Impish queries and statements from the system ("Hi, Jenny, what do you want to practice today"?) may be good for Sunday supplement articles or initial contact, but they seldom are really helpful.

Just a few general questions may cover many of the problems that a novice faces. Nievergelt offers four:

Where am I?	(When the screen looks different from what the user expected)
What can I do here?	(When the user is unsure about what commands are accessible)
How did I get here?	(When the user suspects some entry mistakes)
Where else can I go?	(When the user wants to explore the system's options)

Answers to these questions must be easily available if a nonexpert user is to keep going. A parenthetical observation is that, in modern computer systems, very little of the system is visible unless the systems programmer decided to make it so; in modern systems there are few sound or mechanical cues as to what is happening at any given instant; the black box is impenetrable.

A strong implication for system designers is that, along with the system operating model itself, there must be produced a "user's model." The user's model should incorporate a near-novice view of such things as the kinds of objects, files, records, graphics, and characters, the means of referencing items and objects, the options available for arranging objects in sequences and hierarchies, the

commands for causing things to happen, and other matters such as edit and replay techniques. Furthermore, the user's structure should be explainable and comprehensible within a half-hour or so, and it should not surprise the user when he actually gets on the system. The system should be reasonably self explanatory so that the user does not have to do much searching in technical manuals.

Researchers in the human factors domain may be a little uncomfortable with man-machine analyses like those offered by Nievergelt. The reason is that his ideas and proposals and design suggestions come not from laboratory or simulation studies, but rather from a shrewd, rather common-sense observation of people who are trying to use complex systems. Perhaps some ergonomics researchers have concentrated too quickly on straightforward and researchable display and input-device problems, and have abandoned much of the field to the common-sense observation of computer practitioners. It is difficult, for instance, to think of a single "user's model" that has come from an ergonomics laboratory.

Nicholas A. Bond, Jr.

ONR London

COMMUNICATION SCIENCES

THE 71ST CONVENTION OF THE AUDIO ENGINEERING SOCIETY

In March 1982, the Audio Engineering Society, an international organization, held its 71st convention, (the 12th in Europe), in Montreaux, a small town on Lake Geneva in Switzerland. The meeting, which attracted 1,500 participants and 1,000 exhibitors, took place in the newly enlarged Maison des Congrés.

The society was founded in 1948 in the United States to bring together people concerned with the engineering aspects of acoustics and sound reproduction and the manufacturers and users of audio equipment. Its conventions, which have provided a forum for technical papers in these areas, soon began to be accompanied by equipment exhibitions. These gradually expanded to become the most important exhibitions, in both the US and Europe, for professional sound recording and reproducing equipment.

The society took on an international character in the 1960s with contributions to its technical sessions from [illegible], followed by the formation of British and European sections and the first European convention in 1970. Now, in addition to its headquarters in New York, the society has an office in Britain and a European office in Holland that serves 10 sections.

Though the official language of the convention was English, most European languages were heard around the exhibit stands. There were 45 exhibits from the US and more than double that number from western Europe. The latter group included 29 from the UK, 10 from Switzerland, 6 each from Denmark and France, 1 from Lichtenstein, and others from Austria, Belgium, Finland, The Netherlands, Norway, and Sweden. Canada, Czechoslovakia, Hungary, and Israel were represented with one exhibit each. Surprisingly, there were only six exhibits from Japan, which is usually very much in evidence at the US conventions.

The conference had six regular sessions and a special evening session. The regular sessions were devoted to the following topics: measurements and instrumentation, studio techniques and transducers (2); sound reproduction, sound reinforcement and acoustics, and digital audio hardware. The special session featured papers on digital techniques. In addition, there was an electronic music workshop. As abstracts of all the papers will be published in the society's journal and preprints of many of them are available, only a few are discussed here.

The first paper of the convention, a tutorial overview by Dr. J.A.M. Catrysse (Katholieke Industriële Hogeschool, Oostende, Belgium) dealt with mathematical transforms and their application to filtering techniques, a topic of increasing importance in the digital era but unfamiliar to most audio engineers. This was followed by a presentation on instrumentation for voice analysis (useful for speech therapy) and for measurement of the relative loudness of broadcast signals. The third paper discussed the amplitude distribution of modern recorded music.

The sessions on studio techniques started with a paper from Studer International, of Regensdorf, near Zürich, on analog circuitry for recording and reproduction, still a valid competitor for digital techniques, and continued with several presentations on instrumentation for studios. There were two interesting papers on phonograph cartridges. The first, by T. Groth and F. Nygaard (Ortofon, Denmark), discussed a mathematical model of a moving coil cartridge, from which both amplitude and phase response could be derived, and outlined a procedure by which both could be measured by means of an accelerometer instead of the more usual standard recording. The second, by E.D. Park (Audio Dynamics Corp., New Milford, Conn.) described an experimental cartridge design in which the effective compliance could be adjusted by the user to place the resonance between the tone arm and the cartridge at a desirable frequency, about 10 Hz.

In the session on sound reproduction, there was a particularly interesting paper by C.P. Janse and A.J.M Kaizer (Philips Research Labs., Eindhoven, Netherlands). They use a

basic time-frequency distribution, known as the Wigner distribution, to describe and evaluate the performance of loudspeakers. There was no preprint, but the full paper is available from the laboratories.

The session on sound reinforcement and acoustics contained a paper by R. Berkowitz and R. Generaux (Teledyne Acoustic Research, Norwood, Mass.) describing an adaptive processor that computes and implements a digital filter to invert the power spectrum of an electroacoustic system and thus can compensate for room modes, loudspeaker directivity, and boundary absorption of high frequencies at a given listener position.

Dr. Barry Blesser, formerly of MIT, began the special evening session on digital techniques with a discussion of some of the philosophical traps of digital audio. He said that, while digital audio represents a quantum jump in technology and also in price, one must be careful in making comparisons between two alternative components in an overall system, as performance limitations in one of the two components may well mask a deficiency in something elsewhere and thus result in a more pleasant sound. (In his presidential address at the awards banquet, Blesser described the present time as the period when digital audio was coming of age.) Blesser was followed by Dr. F.H. Hirsch (EMT-Franz, West Germany), who discussed approaches to a digital microphone. He used the operation of the human ear as an example and concluded that the process would most probably require two steps, conversion of sound, first, to an analog voltage and then to a digital signal, so that the performance of the diaphragm would remain a limiting factor. (Indeed it appears to the author, also, that since propagation of sound in the medium is essentially analog in character, the transducers, both microphones and loudspeakers, must be analog devices.) The third paper, by J. Jecklin (Swiss Broadcasting Corporation), treated the problem of the actual reproduction in a living room of the large dynamic range now possible in digital recording. Following Jecklin, H.A. Jones and D.A. Tilsley (Ruper Neve Company, Royston, UK) discussed the problems encountered in the development of digital mixing consoles, in particular a prototype designed and produced in collaboration with the British Broadcasting Corporation.

Studer International, of Regensdorf, was mentioned earlier. It is appropriate to conclude this report by noting that, at the awards banquet, the gold medal was received by Willi Studer, who has already received the honorary degree of Doctor of Technical Science from the Swiss Federal Institute of Technology and whose name is a household word on both sides of the Atlantic for the highest possible quality in recording equipment.

G. L. Wilson

Pennsylvania State University

THOMSON-CSF'S CENTRAL RESEARCH LABORATORY

The Central Research Laboratory (CRL) of Thomson-CSF (Compagnie Sans Fil) is in Corbeville, a part of the Parisian suburb of Orsay. My host (and covisitor) was Dr. Claude Dugas, the scientific director of Thomson-CSF. (His own office is in the corporate headquarters in the center of Paris.) Dugas wears two hats in the Thomson organization; he is also the scientific director of Thomson-Brandt, the group of companies that includes Thomson-CSF as its largest unit. At the time of the visit, a new governmental policy, nationalization of large elements of French commerce and industry, had been established and means to achieve that end were being formulated. Dugas explained that Thomson-CSF, was not, per se, a candidate for nationalization, but, in effect, control of the company would rest with the government through a combination of circumstances: the imminent nationalization of Thomson-Brandt, which holds 42% financial control of Thomson-CSF, and the fact that the already-nationalized banks own an additional 9%. There were no conjectures during the discussions about the possible effects of this type of outside control on the laboratory's R&D program except for the comment that Renault, a completely nationalized company, appears to have prospered under such an arrangement and enjoys a high degree of managerial freedom.

Research and development expenditures for Thomson-CSF as a whole are about 3.5 billion francs ($557 million) per year. Only about 10% of the research takes place in Corbeville; the rest is done in the laboratories of the operating divisions. Within CRL, 15 to 25% of the work is pure research, i.e., physical and chemical studies of materials and processes, and 60 to 70% is in applied research, e.g., high-speed digital, microwave, and optical integrated circuits and subsystems, display devices and man-machine interfaces, fiber optics, computer systems, and cryptography. (The remaining 10 to 20% of the laboratory's work is the direct support of the operating divisions through consulting on specific projects.)

Dugas described a novel, perhaps unique, method that is used by CRL to support certain applied research projects. Instead of the conventional approach, wherein the laboratory assigns its own staff members to carry out the research and then passes the results on to the appropriate operating division for implementation, CRL sometimes transfers a large group of researchers from an operating division to the CRL "campus" where they pursue the research program. When the project has reached an appropriate stage, the group is returned to its own division to proceed with the implementation or product-development phase. A current case in point involves about 300 people from Thomson- CSF's Components Division who, as resident researchers at the Corbeville facility, are working on studies related to gallium arsenide.

Dr. Michel Peltier, the head of the signal processing components section, reviewed some of that group's activities with gallium arsenide components. In support of the company's radar division, Peltier's section is developing medium-scale, integrated, digital and analog integrated circuitry. Two examples were discussed: a flip-flop circuit which generates half the frequency of the incoming signal, and a digital memory unit. Three designs have been studied for the flip-flop frequency divider: a high-powered, high-speed version and two types that trade off the speed (or bandwidth) for lower power consumption. The design that operates at the highest speed uses a depletion-mode buffered field-effect transistor logic device (DBFL) in a dual-clocked circuit configuration. At an average power level of 60 mW/gate, the circuit operated with input frequencies up to about 5.75 GHz and a figure of merit (a power-delay product that, as with golf scores, is better at low values) of 5pJ per gate. An order of magnitude of improvement in the figure of merit was achieved with a low-powered version of DBFL. (Lower power is achieved through a change in the "pinchoff" voltage from a value of about -2 V in the high-speed design to about -0.7 V in the low-powered model.) The low-powered device, which was used in a different circuit configuration—more suitable for eventual use in large-scale-integration form—operated with input signals up to about 2.2 GHz. The third design fitted roughly between the other two in terms of figure of merit, bandwidth, and the density of gates on a chip. It uses a nearly zero pinchoff voltage with an enhancement-mode approach. Devices of this type have been operated over a wide range of characteristics, with figures of merit in the 0.23 to 2.8-pJ/gate range, corresponding to operating frequencies from 0.7 to 2.8 GHz, respectively.

So far, work on memory circuits has been limited to small-to-medium-scale integrated 4- and 8-bit shift-register memories. The 8-bit version was described as having an access time of about ½ ns and a power consumption of 90 mW.

Another member of the CRL staff, Dr. Claude Puesch, the leader of the integrated optics section, described work in his area. Much of it involves the use of optical phase modulators in analog and digital communication systems and in instrumentation applications. The basic phase-modulating element is a piece of titanium-doped lithium niobate whose index of refraction is controlled by the electric field intensity applied perpendicularly to the wave's direction of propagation. The integrated optics section began studying this type of element about 10 years ago; some of the problems are related to the new system configurations being used and the coupling of the wave into and out of the modulator element through two single-mode (2- to 3-μ diameter) optical-fiber waveguides. The solution to the coupling problem was twofold. First, Puesch and his associates developed an etching process for controlling the shape of the fiber's tip. This produced a suitable diffracting lens that eased the alignment problem by taking its required accuracy out of the submicron range. Then they developed an alignment scheme that positioned the fibers and the interconnecting modulator element onto a common substrate. The alignment was accomplished by a set of parallel grooves, set into the substrate's surface, which matched up with a set of protrusions on the modulator subassembly. One of the grooves (that extended beyond the modulator in both directions) was used to position the cladded input and output fibers. In 1980, before these techniques had been developed, the total insertion loss for a modulator was about 10 dB (made up of about 3 dB coupling loss at each end and about 4 dB insertion loss for the basic modulator assembly). Puesch reported that, with an improved basic modulator, they have reduced the insertion loss to about 3 dB (made up of about 1.3 dB coupling loss at each end and an insertion loss of about 0.4 dB for the modulator, which is about 4 cm long). He said that the coupling efficiency is still limited by the accuracy with which the fiber is centered within its own cladding.

As part of their system configuration studies, Puesch and his associates have built a variety of two-channel interferometers, with the phase modulator included in one of the channels. The differential phase shift that is introduced is used to cause amplitude modulation of the wave at the combined output. Electronic feedback, used with this type of interferometer, produces a bistable device; they have used such a configuration to pulse modulate the output of a continuous wave laser (1-ns pulses were generated) and as part of a switched directional coupler (with a switching speed of about 500 ps and a "cross-talk" level of -30 dB). For use in a multilevel amplitude modulator, they split the control electrode into five separate sections. The sections are independently excited in parallel by a set of binary voltage levels, each corresponding to the five digits of a binary representation of the desired number. The weighting of the digits in that representation is matched by the relative lengths of the electrodes, so this arrangement provides a simple, high-speed method for achieving 32 levels of phase modulation. Then, in the interferometer configuration, a 32-level amplitude modulator is provided.

Puesch also described the work his section is doing on optical-fiber gyroscopes. As with other ring-laser gyroscopes, these devices measure rotation by using the Sagnac interferometer effect over a closed path, i.e., the introduction of a differential phase velocity between two counterpropagating waves in a medium by rotation of the medium. The sensitivity of such devices (measured as a difference in propagation delay in the two directions) is directly related to the "effective" area defined by the closed transmission path, which, in

turn, is proportional to the number of times the path is traversed before the differential time delay is sensed. Therein lies the attraction of the fiber waveguide configuration. CRL's design uses a 3,000-turn coil with a diameter of about 20 cm. In the integrated system, they succeeded in reducing error rates to the order of 0.1 to 1.0 degree/hr. Puesch indicated that this type of work was discontinued recently because of lack of interest on the part of the "sponsor," but the 3,000-turn coil has not been idle. One of the members of the group, Dr. Hervé J. Arditty, described a system that uses the coil to measure very high values of electric current. Electricité de France, the national electric power utility, is the sponsor; the company's interest lies in the measurement of lightning-induced leakage currents exceeding 1,000 A. The system uses the Faraday phase-shift effect in the fiber, which is induced by the current-carrying conductor that goes through the center of the coil. The coil is located in one channel of another two-channel interferometer configuration. Arditty commented that the system is of interest because it is less sensitive than ferromagnetic current transformers to the presence of nearby magnetic materials, and it has better characteristics in other environmental respects.

Thomson-CSF's CRL is one of the most prestigious industrial electronics research laboratories in Europe; the sampling of activities to which the author was exposed supports that reputation. It remains to be seen whether the political changes introduced into the industrial environment will affect the way that CRL people are guided in their efforts and, thereby, the morale of the staff and the quality of the work they do.

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COMPUTER SCIENCES

COMPEDA—AN ORGANIZATION DEDICATED TO SOFTWARE TECHNOLOGY TRANSFER (UK)

COMPEDA is the name of a company founded by the UK National Research Development Corporation (NRDC) in 1979 to provide product support and worldwide marketing for high-technology software products developed by government-sponsored research organizations. The organizations include the Science and Engineering Research Council (SERC), universities, and other government laboratories. It often happens that university- and laboratory-developed software is inadequate in documentation and difficult to use and maintain. COMPEDA's role in accelerating technology transfer is to test, document, and provide user proof for software products, to market them, and to maintain a service organization to support the users.

For the first 2 years of its existence, 1979 and 1980, COMPEDA incurred a cumulative loss of £1.4 million on total sales of £1.0 million. This reflects the heavy start-up costs for such an organization. However, COMPEDA broke even in 1981 on a total revenue of £2.8 million. It is forecast that COMPEDA will show a profit of £1 million on sales of £4.5 million in 1982. If such a profit materializes, it would be a remarkable success story. Now COMPEDA has overseas offices in the US, Europe, and Japan that are actively marketing its software products. A list of COMPEDA products is shown in Table 1 on the following page.

How did COMPEDA do it? By offering full product packages to users in a growing software market area. The packages are licensed for use by industry complete with documentation, training, long-term maintenance, and continuing support. COMPEDA believes that effective project management is a vital part of engineering design. Most COMPEDA products incorporate facilities for conceptual design, design analysis, drafting, and the production of manufacturing information. These are generally classified as the rapidly growing market area of computer-aided design and computer-aided manufacturing (CAD-CAM). However, COMPEDA prefers the term "computer-aided engineering". The majority of the COMPEDA staff have engineering backgrounds with particular emphasis on engineering applications relating to manufacturing. Therefore, selected software products based on the latest university and laboratory technologies can fulfill the real requirements of engineers in industry. In other words, irrelevant hobby-shop software is not marketable. In addition, COMPEDA has technical support teams at each of the domestic and overseas support centers to advise users and to provide local liaison and training facilities. Some of COMPEDA's major products are described briefly below.

GAELIC Integrated Circuit Design System (ICDS)

GAELIC-ICDS was originally developed by the University of Edinburgh to provide a comprehensive set of tools for designers of large-scale integrated circuits. It removes from the designer the need to perform many tedious routine tasks. The new levels of integrated-circuit complexity in very large scale integration today render it almost impossible for one individual to handle the total design task. GAELIC provides necessary aids to solve the design and management problems in large systems.

NAME	DESCRIPTION	DEVELOPED BY
PDMS	Plant Design Management System	Department of Industry; Computer Aided Design Centre, Cambridge
PEGS	Project Engineering & Graphics System	Department of Industry; Computer Aided Design Centre, Cambridge
WHESSOE PSA5	Pipe-Stressing System	Whessoe Heavy Engineering
GAELIC	Integrated Circuit Design Systems	University of Edinburgh
DRAGON	2D Drafting System	George Wimpey ME&C (Design Office & Group Management System Dept.)
DUCT	3D Surface Modelling System	Cambridge University
SPLICE	System for Synthesis of Spline Curves	Cambridge University
SAMMIE	Human Factors System	Nottingham University
TIMELINK	Work & Job Analysis System	Nottingham University
NULISP	Assembly Line Balancing System	Nottingham University
SWORD	Production Scheduling System	Atomic Weapons Research Association, Aldermaston
CAPE	Process Planning System	Department of Industry; National Engineering Lab., East Kilbride
REMUS	Electromagnetic Engineering System	Rutherford & Appleton Laboratories SERC
BIM2D	2D Magnetic Field Analysis	Rutherford & Appleton Laboratories SERC
PE2D	2D Magnetic Field Analysis	Rutherford & Appleton Laboratories SERC
TOSCA	3D Magnetic Field Analysis	Rutherford & Appleton Laboratories SERC
CLADP	Control System Analysis & Design	Cambridge University
FLATPAK	Flatness Analysis	Department of Industry; National Physical Laboratory, Teddington
MOSAIC	Finite Element Stress Analysis	Leeds University
SECT-F	Exhaust System Analysis & Design	Southampton University

Table 1. COMPEDA Products

GAELIC begins with the computer-aided drafting of logic circuit diagrams. Logic simulation checks the operation of circuits to detect timing problems. Input of mask layout data on full-color terminals allows each mask to be identified by a different color. Editing facilities in color gives on-line capability for modifications of mask layout. Design rule checking verifies that the mask layout conforms to designer-specified rules concerning spacing, track width, etc. The designer first specifies the design rules in a definition language. The specifications are syntax checked and compiled into a rule source file. The rule checking program enables the layout data to be scanned for rule violations using the compiled rule file. Variable-sized library cells can then be individually designed, verified, and tracked to produce, eventually, a dense final-chip layout. Final-chip-mask layouts can be made directly to the interface of the fabrication process.

GAELIC-ICDS operates on a wide range of medium-scale computers including DEC PDP-10, PDP-11 and VAX, PRIME series, and IBM 370 in batch or time-sharing modes. It can be used by designers with no knowledge of programming. GAELIC-ICDS is technology independent. It has been successfully used in most current designs including bipolar, silicon-on-sapphire, and others.

Plant Design & Management System (PDMS)

PDMS takes into account existing energy supplies and alternative energy sources. It is used to assist the engineer in all aspects of plant design for the energy processing industry and in designing the associated pipework. PDMS was developed in Cambridge to tackle the problem of plant layout, pipe routing, and pipe work design to manage three-dimensional (3-D) space. It enables a designer to build a detailed and dimensioned 3-D model. A graphics terminal can then be used as a window on the model. PDMS also manages catalogs, specifications, standard equipment components, and materials lists. It has the capability of storing and interrogating all this information in an entire complex plant. The data can then be assembled for detailed analysis, design, and audit for economy and safety, and they can be queried by design engineers and personnel at the construction site. The plant model can be kept, referred to, and maintained throughout

its life, enabling continuous audit of maintenance updates. There are several other COMPEDA products to augment PDMS, including a pipe stressing system and project engineering and graphics systems.

Production and Manufacturing Aids

Assorted software packages are available in this area. The centerpiece is the two-dimensional general drafting system called DRAGON. It has the capability of producing a wide range of two-dimensional engineering drawings in a variety of sizes and formats, including orthographic views, electrical schematics, pipework and instrumentation diagrams, architectural layouts, etc. There is, in addition, a three-dimensional surface modeler that enables designers and manufacturing engineers to create and manipulate complicated shapes. This is further supported by a three-dimensional system for evaluating the ergonomic aspect of a design. There are other work-study, production-scheduling, and control systems available to provide a total package.

Special Systems

There are special engineering analysis systems in which the UK has a clear lead in the world. Typical is the SERC magnetic analysis system REMUS, which enables a designer to optimize interactively in both two and three dimensions, and the Cambridge Linear Analysis and Design Package (CLADP) for interactive analysis and design of complex control systems.

Summary

COMPEDA has significantly penetrated the select but rapidly growing computer-aided design - computer-aided manufacturing software market. As a government-owned organization, it has a reservoir of government-sponsored software developed by universities and government laboratories to choose from and to make into marketable software products. When the corporation matures, relevant products from this reservoir will become rarer. The academic community must continue to supply good high-technology software product candidates in order to sustain COMPEDA's competitive edge in software technology. As support and maintenance of software products are labor intensive, when the product line becomes more diversified, human resources will ultimately constrain its growth. Meanwhile, COMPEDA is a unique mechanism to effect software technology transfer.

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ONR London

ENVIRONMENTAL SCIENCES

THE WEST GERMAN POLAR RESEARCH PROGRAM: PAST AND PRESENT

The origin of Germany's polar research program can be traced to 1868, when Capt. K. Koldewey led a voyage of discovery into the north polar seas. In 1882 and 1883, Germany took part in the first International Polar Year.

By the end of the 19th century, the British, French, and Americans were very active in both arctic and antarctic research, and the Germans began to focus attention on the southern region also. On the urging of the director of the German Coast Guard, Georg von Newmayer, the German Commission for South Polar Research (founded in 1895) sponsored a geophysical expedition to Antarctica. A special research ship, the Gauss, was constructed in 1899-1900, and in 1901-1903 Erich von Drygalski, a renowned geographer, led an expedition to the south polar seas. Named after Carl Friedrich Gauss for his work on earth magnetism, the Gauss was a triple-planked (oak), 1,442-ton, sail and steam-powered icebreaker, which left Kiel, Germany on 11 August 1901 and finally met pack ice on 14 February 1902. Undamaged after 14 months, the ship left the pack ice laden with new data and returned to Kiel on 25 November 1903. (The Canadian government bought the Gauss in 1904, and, renamed Arctic, it served as a Coast Guard research and patrol vessel until 1926.)

In 1911-1912 the Deutschland, under W. Filchner, spent 8 months locked in the ice of the Weddell Sea; in 1938-1939 the Schwabenland Expedition conducted an air-photographic survey of Antarctica under Capt. A. Rilscher. Thereafter, the Germans waited nearly 40 years to launch another antarctic expedition. Meanwhile, various voyages of research and discovery were made into the north polar seas, including participation in the International Polar Years 1932-1933 and 1957-1958.

With rising economic and political interest in the polar regions, especially Antarctica, the Federal Republic of Germany (FRG) decided in 1978 to revitalize its polar research program. In May of that year FRG joined the Scientific Committee on Antarctic Research (SCAR), and on 5 February 1979, FRG signed the Antarctic Treaty. Included in the new program was the founding of a polar research institute, the installation of a permanent station in Antarctica, and the building of a special icebreaking research and resupply ship.

The desire to gain acceptance under the Antarctic Treaty provided the main impetus for FRG's dramatic expansion of its polar research program. The treaty, which now holds the signatures of 14 nations and is effective until at least 1991, suspends all territorial claims in Antarctica, permits free access for peaceful purposes, and prohibits any military action. So far, it has been universally honored, but with the potential for development of the region's vast food, energy, and mineral resources, the

treaty nations are hoping to resolve Antarctica's future among themselves.

In July 1981 the treaty nations met in Buenos Aires to negotiate an agreement governing mineral exploitation, a topic not covered by the original treaty. Earlier, FRG had sent the Polar Circle into the Weddell Sea to install a new research station near Atka Bay, but anxious to complete the task prior to the Buenos Aires meeting and unable to break through the ice in time, they established the station 750 miles from its intended location. Nevertheless, the Georg von Neumayer Antarctic Research Station was made permanently operational with logistic support provided by the new polar institute. Having thereby demonstrated its interest and commitment in the region, FRG was finally accepted into the consultation rounds on the Antarctic Treaty on 3 March 1981.

Organization and Support

The new FRG polar research program has been implemented through the research programs of various universities, federal and state research institutes, and private research organizations. Support has come mainly from government agencies, including the Federal Ministry for Food, Economy and Forests, the Federal Ministry for Research and Technology, and the Federal Ministry for Trade.

The FRG polar institute coordinates the polar oriented research programs of other institutions on both the national and international levels and also conducts its own research program within the framework of the national program and the German SCAR membership. The polar institute is also responsible for the management and support of the antarctic station and the new research and resupply vessel (under construction). Ninety percent of the polar institute's support is provided by the Federal Ministry of Research and Technology with most of the remainder coming from the State of Bremen. The state's obligations include funding five university professors in polar oriented studies in association with the Institute of Marine Sciences and the polar institute.

The Alfred Wegner Institute for Polar Research

The polar institute was founded in Bremerhaven in 1980 and named for the famous geophysicist, Alfred Wegner, who died on the Greenland ice in 1930. The institute currently occupies temporary offices, but construction of a building to accommodate 150 people, including researchers and students, will begin in 1984. There are plans to accommodate another 250 people. The institute is governed by a board of representatives from the federal and state governments and the scientific and business communities plus others. A scientific council advises the board.

The following describes the responsibilities and scientific interests of the polar institute:

Purpose. The most important objective of the polar institute, apart from serving as a national center for coordinating research activity and information, is to serve as an independent research center that promotes international cooperation.

Logistics. The logistic responsibility of the FRG polar institute is to transport scientists, equipment, and supplies to the antarctic station and to care for equipment in summer storage. The institute must maintain the antarctic station and the polar ship as well as a fleet of vehicles. It is also responsible for the employment of necessary helicopters and airplanes.

Research Program. The quality of the scientific program of the institute clearly depends upon the researchers who can be brought to work at the institute. In its endeavor to meet its commitments and attract top quality researchers, the institute plans to concentrate on the following areas of interest:

The geological development of Antarctica during the earth's middle era will be studied. During the Mesozoic period, the precontinent broke into several pieces and Antarctica separated from South America. The research will extend to both the sea floor and the rock structures in the neighborhood of the Weddell Sea. Research into the ice of Antarctica is of particular interest. For this purpose an adjunct summer station will be built on the ice shelf. The present central station is already recording measurements of ice movement.

The institute also intends to conduct meteorological research in the polar regions. The changing conditions between shelf ice, sea ice, atmosphere, and open sea, and the influence of these upon the temperature and circulation of air and water masses will be studied through measurement programs and mathematical models. The FRG polar research ship is being specially equipped for such work. The meteorological program of the institute will be conducted in cooperation with other research institutes and the German Weather Service.

The polar ice is a good indicator of climatic trends and oscillations. Climatic variations are related to the growth and recession of the arctic and antarctic ice masses. This can be seen in marine sediments and beach deposits. For this reason meteorologists, geologists, and glaciologists will examine such interrelations and the oceanographer will try to compare through their findings the sea currents of earlier times with those of today. Another area of interdisciplinary cooperation lies in bringing together oceanography and biology through research into the environment of the polar seas. Scientists will study both the northern and southern polar fronts and a further front between the Weddell Sea and the Scotia Sea where phytoplankton and zooplankton tend to concentrate. The biology and physiology of polar organisms will also be studied with a focus on the interdependence between research of terrestrial and marine organisms.

Although antarctic research will be stressed during the next few years, the program of the FRG polar institute is oriented toward research in both polar regions. The use of the polar research ship in the arctic, a series of bipolar comparative experiments, and the use of arctic, antarctic, and alpine ice fields for equipment tests have already been planned.

International Objectives. Although the polar institute supports the growth of polar research according to the ordinances of the FRG, there is some ambivalence between the political and scientific goals; polar research is made as effective as possible (through international cooperation and work sharing). The institute plans to cooperate closely with both domestic and foreign universities and other scientific organizations. The institute will have scientists and technologists working on foreign research ships and in foreign laboratories and will invite foreign scientists to Bremerhaven. The institute will promote the importance of polar research through lectures, publications, exhibitions, and other efforts.

The Polar Research Ship.

The new ship, with estimated cost of approximately 200 million German Marks ($87 million), is currently under construction near Kiel. It is scheduled for completion in the fall of 1982 and will enter sea trials off Greenland and Norway during the following winter and summer. Afterwards, the ship will probably go to Antarctica during the period of October 1983 to May 1984 and return north again for MIZEX (an international marginal ice zone experiment) in the summer of 1984. Germany has offered the use of the ship for MIZEX as a primary research platform (frozen into the ice). For a detailed description of the ship refer to: Das Deutsche Polar-Forschung und Verorgungsschiff, HANSA-Shiffahrt-Shiffbau-Hafen 118, Jahrgang 1981—Nr. 17. An English translation is avilable from ONR London.

R. W. Booker

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MATERIAL SCIENCES

POWDER COMPACTION: FUNDAMENTALS AND RECENT DEVELOPMENTS

At a meeting of the Institution of Mechanical Engineers in London on March 24, 1982, Prof. Dr. H.F. Fischmeister, Director of the Institut für Werkstoffwissenschaften, Max-Planck-Institut für Metallforschung, Stuttgart, FRG, presented an invited lecture - The 18th John Player Lecture - on powder compaction. The highlights of his paper are reported herein.

Fischmeister began with a brief historical summary of powder metallurgy processing, pointing out classical cases of the application of the technology, such as Wollaston's work on platinum and Coolidge's tungsten development, which essentially made today's electric lamp industry possible. He then reviewed the powder compaction process itself, starting with a discussion of the shape of various types of powders currently used and the role that shape plays in determining the green strength of compacted bodies. He pointed out, for example, that spherical powders, produced by gas atomization processes, pack to a high density when poured in a die but suffer little deformation during compaction to relatively high densities and thus produce little interparticle bonding and low green strength. Irregularly shaped particles, on the other hand, such as are produced by gaseous reduction or electrolytic processes, do not pack to high density when poured into a die, but undergo much sliding and deformation during pressing. This results in significant interparticle bonding and high green strength. Fischmeister said that, contrary to intuition, mechanical interlocking of irregular particles contributes little to green strength; experimental evidence points to cold welding of particles as the major source of green strength.

In his discussion of the compression behavior of powders, he noted the three stages of compaction accepted by many researchers in the field:

> Stage I Packing, during which particle rearrangement takes place and density rises rapidly.
>
> Stage II Elastic-plastic deformation, which he terms unimpeded contact deformation. In this stage the densification rate slows and, in the case of ductile particles, densification is attributed to the plastic flattening of particles at their contact points.
>
> Stage III Work hardening or fragmentation, in which the rate of densification drops further and approaches zero. Fischmeister calls this the stage of "constraint hardening" and feels that it is reached when adjacent contact areas on the same particles impinge. Further densification during this stage is a result of material being squeezed along the areas of contact into the pores in an extrusion process.

Fischmeister modeled the above processes as they relate to spherical particles, and by using a law-of-mixtures type of approach that takes into account the fact that some regions of a compact are in stage II while other regions are

in stage III, he was able to show remarkably good agreement between theoretical and experimental curves of relative density vs compaction pressure for closely graded spherical bronze particles. He also noted that irregularly shaped particles also fitted the model after some deviation during the early (low pressure) stage of compaction.

For die pressing, Fischmeister reviewed tooling principles, pointing out the importance of maintaining a constant compression ratio (fill height: compressed height) throughout the powder compact being pressed in order to minimize differential shrinkage during subsequent sintering. For a similar reason he discussed friction during pressing. He illustrated how these difficulties could be overcome by clever die design, often involving multiple punches, multilevel split dies, and specific die filling sequences. He pointed out that while much had been done in the area of die tooling and die lubrication, many opportunities existed for the development of more sophisticated press designs, better pressing sequences, and better methods for detecting pressed compacts with flaws at the press rather than after parts had been through more costly sintering and finishing operations.

He also spoke about the merits (e.g., better density distribution than in dies, ability to compact hard metals, ability to compact large or long parts) and drawbacks (e.g., long pressing cycles and low production rates) of isostatic compaction. His remarks covered both the wet-bag method, in which the powder to be pressed is put into a flexible container and immersed directly in the pressing fluid, and the dry-bag method, in which the flexible container is an integral part of the inside wall of the pressure chamber. While he said that true isostatic compaction was not possible with the dry bag method, he noted that it was a particularly useful technique for producing long tubular sections. A Swedish project for making engine cylinder liners 115 mm in diameter and 230 mm high at a rate of 120 parts per hour was an example of the higher production rates capable with this method. In this case pressing was carried out using a central mandrel at 40 MPa followed by sintering and coining.

In discussing hot compaction processes, Fischmeister dwelt mainly on hot isostatic pressing (HIP). He touched on the important hardware problems and the use of Ashby type deformation maps to predict the densification possible for various materials under specified time-temperature conditions. He then went on to illustrate the use of the process for compacting hard metals, superalloys, and tool steels.

In the case of hard metals, he pointed out that, when conventionally made, such materials exhibit minute pores that, although few, act as stress raisers and have a marked effect on mechanical properties. By HIP treatment the pores can be filled and mechanical properties improved. As a result, most hard metal parts to be used in critical applications are given a HIP treatment at some point in the processing cycle.

For superalloys, powder metallurgy and HIP methods are of interest for both technical and economic reasons. In the first place, the powder approach results in material inherently more homogeneous than can be obtained by a cast ingot approach. From an economic standpoint, the ability to HIP process to nearly finished shape means significant savings in terms of machining and materials costs, especially when complex parts such as turbine discs are being fabricated. Fischmeister pointed out, however, that although many powder metallurgists felt that such parts could be HIP processed to essentially finished shape with complete assurance as to properties, gas turbine manufacturers would not allow this. To satisfy them, the parts had to be processed first to an intermediate shape compatible with ultrasonic nondestructive testing methods before the final shape was produced.

According to Fischmeister, tool steel production is being carried out by means of HIP processing by a number of manufacturers throughout the world in large tonnage quantities. The reasons for this were similar to those mentioned for superalloys, lowered segregation with better carbide distribution and less scrap production. Better carbide distribution results in improved toughness, grindability, and dimensional stability during heat treatment, but early claims of substantial increases in tool life have not been realized. For such materials, however, Fischmeister believes that powder processing techniques other than HIP, such as hot extrusion of powders and powder forging, would be satisfactory alternates. In addition, he mentioned spray casting (see ESN 36-2:42 [1982]) as a possible approach for fabricating these materials.

Fischmeister concluded his paper on compaction methods by reviewing powder forging and powder rolling techniques. Powder forging is particularly appropriate for powders that cannot be compacted economically by HIP processing. Heat treatable alloy steel powders are an example. The powder forging process uses a porous preform that is heated in a protective atmosphere and closed-die forged. Because the process does not develop areas of elongated inclusions such as are developed in conventional rolled and forged parts, powder-forged parts do not exhibit "planes of weakness," which can often be a problem in conventionally processed complex forgings. Unfortunately, the high cost of alloy powders has inhibited the more widespread use of powder forging. As regards the direct rolling of powder to sheet, he noted that while the process had been worked out for a number of materials, such as copper, nickel, aluminum, and specialty battery metals, it was not widely used.

Other metal-compaction methods, such as magnetic pulsing and explosive forming, were also touched upon in Fischmeister's review. In

fact, it was the diversity of the techniques available for powder compaction that was emphasized in his conclusions. He pointed out that just 15 years ago a review of the type he had given would have had only one important subject, die pressing. Finally, he observed that the development and the rapid growth in the use of other compaction processes had led powder metallurgists to the belief that they can handle almost any compaction problem-- a hopeful situation, indeed.

P. A. Clarkin

ONR London

SOME METALLURGICAL RESEARCH AT THE KATHOLIEKE UNIVERSITEIT - LEUVEN

The Department of Metallurgy of the Katholieke Universiteit at Leuven, Belgium, was founded in the late 1960s as one of five departments of the Faculty of Applied Sciences. The scientific staff of the department consists of about 40 people, 8 or 9 permanent staff members, the remainder research assistants, PhD candidates, and visiting scientists. The department has three divisions: Physical Metallurgy, under Prof. A. Deruyttere; Chemical Metallurgy, under Prof. J. Roos; and Mechanical Metallurgy, under Prof. P. De Meester, who is also the vice-rector of the university. Recently, Roos and his colleagues told the author about some of the research in progress.

Dr. J.P. Celis is interested in electrochemical deposition of composites, electroforming, and electrochemical methods of recovering metals from dilute solutions. The process for depositing composites electrochemically consists essentially in electroplating a metal of interest from a bath in which fine inert particles are mechanically dispersed. During plating the particles are incorporated in the plated layer. This often produces materials with improved mechanical properties and enhanced wear resistance. For his research, Celis has been plating copper from acid copper sulfate solutions in which alumina particles with diameters of 0.3 to 0.5 μm have been dispersed. Using a current density of about 2 A/dm^2, he produces layers 100 to 500 μm thick that have hardnesses of 150 VHN (that they retain to 500°C) compared to values of 50 VHN for copper plate without Al_2O_3. To obtain flat deposits, the Al_2O_3 content had to be limited to 0.2 v/o. In his studies of the mechanism by which incorporation of Al_2O_3 takes place, Celis found that, contrary to what one might intuitively feel, mechanical entrapment was relatively unimportant. He found that cations were adsorbed on the fine Al_2O_3 particles and as a result they migrated to the negatively charged cathode where they were adsorbed in a two-step process. Celis now is using a rotating disc electrode to get a better understanding of the adsorption process and to determine how the electrochemical and hydrodynamic parameters of the bath affect the process. With the electrode, he has shown that the quantity of Al_2O_3 incorporated can be altered by changing flow conditions in the bath; his setup has been automated to allow him to isolate the variables more easily and ascertain the importance of each to the process.

In closely related work of immediate technological importance, Celis has been attempting to improve the strength and wear resistance of electroformed nickel screens by incorporating fine SiC particles and stainless steel fibers 8 μm in diameter by 2 mm long. He is studying the effects of process variables on the structure and quality of the electroformed part.

A final project Celis described was the research and development of a fluidized bed system for recovery of metals from dilute solutions, e.g., depleted solutions from plating operations and from etching and pickling baths. The motivation to recover the metals is twofold:- conservation and the desire to protect the environment by limiting metal concentrations in waste effluents. The system developed by Celis and his colleagues was designed for the recovery of copper from dilute sulfate solutions, but the concepts are applicable to other types of solutions. The system consists of a stainless steel tube cathode containing copper particles with an initial size of about 200 μm. A platinum anode on the cylinder axis is separated from the copper particles by a porous ceramic sleeve. Sulfate solution is pumped up through the cylinder to form a fluidized bed cathode of copper particles upon which copper from the solution is deposited. The current efficiency of the process is very high, 60 to 70%, compared to less than 1% for more conventional processes, and experiments showed that copper solutions containing 2,000 ppm could be reduced to less than 0.5 ppm by the method. There is an optimum current density for fluidized bed recovery below which the entire bed cannot be cathodically polarized and above which excessive hydrogen evolution results. Similarly, there is an optimum copper particle size. Particles smaller than about 200 μm tend to float out of the bed, while particles larger than 400 μm require higher pumping rates, which reduce particle contact time and lower process efficiency.

Shape memory alloys have been of interest at Katholieke Universiteit for a number of years. Current work on these materials is concentrated on alloys of the Cu-Zn-Al system. Typical fundamental research deals with topics such as the thermodynamics of the transformation process, lattice dynamics and elastic constants, structure of the habit plane, influence of strain rate on the stress-induced martensite phase, pseudoelastic fatigue, etc. In addition, efforts are being made to develop the alloys further technologically . They are being promoted commercially as damping materials and as materials for use in temperature

sensors and self-activating fasteners, under the trade name Proteus, in a joint venture by Leuven Research and Development, N.V. Metallurgie Hoboken-Overpelt, and N.V. Bekaert S.A.

The Department of Metallurgy has been successful in fabricating Cu-Zn-Al alloys via powder metallurgy for the first time. The shape memory effect in the alloys is about the same as that in conventionally processed materials, but the strength and elongation values of powder processed materials are significantly higher due to a fine grained structure, texturing, and the presence of dispersed Al_2O_3 that results from oxidation during processing (UTS - 670 to 800 MN/m² vice 300 MN/m² and elongation - 6 to 8% vice 2.5%). Other developments being pursued are in the use of the alloys in the medical field. One such application, an intramedullary fixation nail, in addition to fixing the fractured surfaces in place, makes use of the shape memory effect to produce compression at the interface to assist in the healing process. Another novel application was the use of these alloys in physical therapy rehabilitation devices. Roos illustrated this in a glove containing alloy inserts in the fingers and hot or cold water lines. The response of the alloy inserts to temperature changes of the circulating water system caused the glove fingers to contract or expand. The glove functions as a relatively simple rehabilitation device that can be used in the home. Although a bimetallic couple could produce similar effects, the force produced by the alloys is 60 times that of bimetallic couples of the same volume.

Besides the medical application of shape memory alloys, a number of other research projects relevant to the medical field are in progress; these concern implant materials. One such project deals with the research and development of bioglass composite materials. Bioglass of composition 45 w/o SiO_2, 24.5 w/o CaO, 24.5 w/o Na_2O and 6 w/o P_2O_5 shows promise as an implant material because of the ability of tissue to grow adherently on the glass surface, but the glass itself is weak and lacks ductility. The goal of the project was to improve the material by incorporating stainless-steel fibers within the bioglass matrix. The processing consisted of forming a 316 L stainless-steel skeleton by pressing and sintering 50 or 100-μm diameter fibers together and then infiltrating the skeleton with molten glass. Composites with 45 v/o of 50-μm diameter fibers or 60 v/o of 100-μm diameter fibers had significantly better mechanical properties; the ultimate tensile strength was about 90 to 100 MPa (about 300 MPa in bending tests) compared to about 40 MPa for the parent glass, and the composites were noticeably tougher. The results of much of the research have recently been reported in the Journal of Materials Science 17 (1982) 595-606.

Prof. E. Aernoudt and his colleagues have been studying plastic deformation in metals. In recent years the work has led to the ability to predict crystallographic textures developed during cold deformation processes of high stacking fault energy FCC metals and BCC metals. Their procedure, which consists of a computer simulation of the deformation taking place in a number of grains of a polycrystalline body (about 300 grains are used), is based on a modified Taylor theory for plastic deformation by multiple crystallographic slip. The agreement between calculated and experimentally observed textures is quite good, although the predicted pole figures are usually sharper than those determined experimentally. In addition, the procedure has been used to predict the texture orientations in shape memory alloys that allow the development of maximum pseudoelastic strain. To do this, they treat the martensitic transformations involved as analogous to crystallographic deformations.

Deformation shear bands have been another subject of interest to Aernoudt. The bands, indicative of inhomogeneous deformation, are often observed in heavily deformed metals. Aernoudt, building on his computer simulation studies of deformation, has proposed that shear bands might be favored as a result of texture development during earlier stages of deformation; he has been conducting research to see if this is a reasonable proposition. His research has revealed nothing that would disprove his proposition, and the increased tendency for FCC metals of high stacking fault energy to form shear bands as deformation due to rolling increases favors his hypothesis. However, the complexity of the deformations involved in shear band formation does not presently permit the mechanisms involved to be completely understood.

Other deformation research efforts of Aernoudt's group include the deformation behavior of two-phased materials, such as pearlitic steel and dispersion-strengthened materials (Cu-Al_2O_3), emphasizing the role of crystallography and texture on the deformation behavior of such materials; the Bauchinger effect in deformed steels and in dispersion hardened alloys, which, Aernoudt says, can affect meaningful hardness measurements in these materials to a degree not realized by most; and fatigue behavior of steel wire heavily deformed by drawing. For the last-named research an improved ac potential drop method was developed for detecting surface cracks. In wires 2 to 4 mm in diameter, cracks with depths of about 1.5% of the diameter could be detected using currents of 0.5 A at 40 kHz. In the study of cracks growing during a fatigue test, however, the frequency is limited to about 5 kHz to reduce noise caused by mechanical vibrations.

The departmental brochure states that research is done in close cooperation between staff members, students, and assistants, and that this tradition guarantees easy technical and scientific cross fertilization. It becomes readily apparent in a visit that these are not just

words for a brochure but are, in fact, a reality. Needless to say, this produces the stimulating environment from which good research flows.

P.A. Clarkin

ONR London

TWO BELGIAN RESEARCH CENTERS

Belgium has many centers responsible for maintaining research laboratories for that part of industry with which they are aligned, for providing consulting services, and for performing some short-term projects. The laboratories are usually at a university but are separately administered. The centers derive about half their operating funds from mandatory industrial contributions and the rest from the government. Two such centers are Centre de Recherches Scientifiques et Techniques de l'Industrie des Fabrications Métalliques (CRIF) and Centre de Recherches de l'Industrie Belge de la Ceramique (CRIBC).

As the name indicates, CRIF is associated with the Belgian metal fabrication industry and works with that industry through the nonprofit industrial association Fabrimetal (Fédération des entreprises de l'industrie des fabrications métalliques), which has more than 1,200 members. CRIF operates laboratories in Brussels (computer-aided design), Leuven (machine building), Ghent (welding), Liege and Ghent (metallic construction calculations), Liege (plastics), Ghent (nonferrous foundry), and Zwijnaarde (ferrous foundry).

Recently the author visited the ferrous research foundry at Zwijnaarde, a suburb of Ghent. Dr. J. Van Eeghem is the director of the foundry which employs 18, of whom 8 are engineers. The foundry's annual budget is 25 million BF (about $550,000). Half of the money comes from industrial contributions, the remainder comes from the government and is administered by IRSIA (Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture). Van Eeghem must justify his research program biennially to IRSIA in order to continue receiving government funds.

The foundry is modest in size but is well equipped and capable of handling projects that range from casting small prototypes to developing full-scale industrial casting processes. Van Eeghem categorized the research at the foundry as dealing either with the metallurgy of cast irons or with the casting process itself. Metallurgical research is concerned primarily with the development of new innoculants for nodular cast iron. M. Lietart, who is conducting the research, was to present the results at the International Foundry meeting in Chicago in April. Most of the activity at the foundry, however, consists of studies of various aspects of the casting process: sands and finning, gating and risering, metal-mold casting, and flaskless casting.

Finning, a term describing the formation of thin, finlike metal platelets often found protruding from the internal surfaces of castings, is attributed to thermal shock cracking of casting cores; the fins form when the liquid metal from the casting body penetrates into the cracks in the core volume. Finning is a defect that is difficult to remove from intricate internal volumes, and it can increase casting costs significantly. Research on the problem focuses on the thermal shock resistance of sand cores and the effects of core processing variables (e.g. sand characteristics, binders, pressing conditions, baking conditions, etc.) on thermal shock resistance.

Research on gates and risers, which is being carried out by F. Mampaey, is an empirical study of the solidification morphology of nodular cast iron bodies. In an earlier study of gray cast iron, Mampaey demonstrated that the minimum riser dimensions needed to obtain sound, defect-free castings could be calculated if one knew the riser rest modulus and the percentage of shrinkage, both of which varied with eutectic graphite content or carbon equivalent and were determined experimentally. He is now making a similar study of nodular cast iron.

Metal mold casting is of considerable interest at the laboratory although research on the process started only recently. According to Van Eeghem, the method, which uses a metal mold with a thin layer of sand on the mold wall, is not used in western industry. However, it is being used in Russia, for example, in the casting of components for hydroelectric turbine generators. Among the advantages of the process is the ability to control dimensions accurately from piece to piece in a production run. In an initial study of the process, G. Van Houtte is undertaking a numerical simulation of solidification developed in the metal mold process and is comparing his results with experimental observations. The results of his work to date were discussed at the NATO-AGARD meeting on Advanced Casting Technology held in Brussels in April.

Flaskless casting, or casting using chemically bonded sands, has been under study at CRIF for a number of years. One of the principal benefits of the process is the energy savings it allows when compared to green sand casting practice. According to Van Eeghem, flaskless casting uses a sand to metal ratio of 2/1 or 1/1 compared to a 7/1 ratio needed in green sand casting. The respective energy costs are 10 Kw/ton for green sand and 6Kw/ton for chemically bonded sand. For a typical Belgian foundry, conversion from green sand to chemically bonded sand molds is expected to achieve a savings of about 600,000 Kw annually. An experimental foundry has been set up to use the process and verify the cost analysis.

CRIBC, the research center of the Belgian ceramic industry, is in the city of Mons. In addition to research carried out at its own separate facility, much of CRIBC's work is at the University of Mons and Mons Polytechnic. Including some university researchers, about 70 people, half of them professionals, are involved in CRIBC sponsored research. Dr. M.R. Anseau, F. Cambier, and C. Leblud outlined the research.

Materials investigated at CRIBC fall into two categories, traditional ceramics and special ceramics. In the traditional ceramics area one of the principal aims of the research is to reduce energy costs and the cost of transporting raw materials. Thus, research focuses on vitrification in ceramics and the development of structural clay products that can be fired at lower temperatures, the use of by-products as fluxing agents, mineralizers and grogs, improvement in temperature control of industrial kilns and computer simulation of kiln operation for effecting improvement in kiln design, the theory of drying and drying procedures for structural clay products. A second major objective of the research on traditional ceramics is to improve the quality of clay used in ceramic processing and to improve slip-casting procedures. Typical projects involve studies of the mineralogy of clays, methods of characterizing clays, and the electrochemistry of clays.

In the special ceramics area, biomaterials research is important. About 20 people, including ceramists, histologists, surgeons, mechanicians, and mathematicians, are involved in the research. For the most part, the group is investigating bioglasses for implants, although some work is also being done with a local hospital on high density alumina for hip prostheses. In connection with this, they are conducting finite element analysis to determine prostheses designs that will yield optimum stress patterns.

Bioglasses are glass ceramic variants of the system SiO_2-Na_2O-CaO-P_2O_5 with a controlled surface ion activity that promotes chemical bonding to bone. For these materials they are conducting both in vitro and in vivo tests of various glass compositions to ascertain surface stability in conjunction with histological studies by the biomedical group at the University of Mons. They rely primarily on microprobe analyses to determine leaching of the glass constituents and diffusion into adjoining areas. The studies are inherently long term, and definitive conclusions are not yet available.

Toughening of ceramics is, of course, of interest to the group at CRIBC, and it is investigating the possibility of using the tetragonal to monoclinic martensitic phase change of ZrO_2 for toughening. In order to produce the ceramics that will use this concept, the group is studying reaction sintering methods, a technique in which it gained some expertise in recent investigations of zircon-alumina reactions.

The final topic Anseau discussed was a computer-aided investigation aimed at quantifying particle morphology mathematically. The research is relevant to both traditional and special ceramics, for it has long been felt that the ability to characterize the size and morphology of starting powders with more precision would lead to improved reproducibility of product properties.

P. A. Clarkin

ONR London

MATHEMATICS

OPERATIONS RESEARCH AND APPLIED SYSTEMS ANALYSIS AT THE UNIVERSITY OF WARWICK

The University of Warwick, in attractive open country just south of Coventry, is one of the new universities founded in England during the 1960's. It has programs in a broad spectrum of subjects, including the arts, social sciences, science, and engineering. One of its most vigorous elements is the Operations Research and Applied Systems Analysis (ORASA) group within the School of Industrial and Business Studies. The school has about 400 students and over 30 faculty members and offers bachelors', masters', and PhD degrees in several programs involving management science, accounting, business administration, and operations research. The ORASA group has about 10 faculty members under the leadership of Prof. Rolfe Tomlinson.

During a recent visit, the author had the opportunity to visit Tomlinson and two other ORASA group members, Dr. Robert Hurrion and Dr. Roy Johnston. In what follows, we describe some recent research activities of these men in the hope that this will represent a reasonable sample of the research activities of the ORASA group. A central theme of the work is that it is driven by problems actually arising in business and industrial concerns in the UK; indeed, all of the researchers gained extensive experience in industry before joining the university.

Tomlinson has served as director of operational research for the National Coal Board. He recently served as area chairman of the Institute of Applied Systems Analysis (IIASA), he is currently president of the European Association of Operational Research Societies, and he is a past president of The Operational Research Society. Tomlinson's work with IIASA demonstrates his research interests. The IIASA is supported by 17 nations, mostly in Europe and North America. The institute employs about 90 scientists from many disciplines. The scientists are appointed by the institute from the various nations in numbers roughly proportional to their respective funding support. Topics

studied recently by IIASA include energy, food and agriculture, resources and environment, human settlements and services, and management and technology. Within the last-named area, Tomlinson's group concerned itself with problems facing management in industrial and governmental organizations arising from technological change. Examples of the problems the group is working on include the management of major programs, innovation, the problem of scale, man-computer interface, and decision making under high risk. In the project involving high-risk management, for example, a study was made of two situations that had a potential for large human and material damages: the oil blowout at the Bravo platform in the North Sea and the Three Mile Island nuclear accident. A comparison of the two incidents revealed a surprising number of identical features. For example, in both cases it was a sticking valve that initiated the accident chain, and in both cases the maintenance program was deficient. In fact, for 17 out of the 29 attributes compared in the study, the situations in the two cases were judged to be the same. Another interesting finding was that contingency plans for dealing with accidents in the two situations were inadequate. Such plans must be flexible enough to cope with the great uncertainties and unpredictable events that face management in accident situations.

Hurrion was one of the first researchers to work on visual interactive simulation. Computer simulation has long been used to give insight into complex problems, but often it does not give a manager an understanding of how a complex problem develops through time, nor does it give him an opportunity to interact with the problem as it evolves; rather, the result is often a set of statistical summaries, compiled after the simulation runs have been completed. Visual interactive simulation is an approach to simulation in which an end-user can watch a model progress through time on a computer display device linked to a computer. The computer simulation is constructed in such a way that the status of the model is dynamically displayed as the simulation progresses. The manager can interact with the model and try alternative strategies or decisions. As a bonus, the approach appears to ease the problems associated with model validation and acceptance of the simulation by the end user. It allows a manager to explore the implications of different decisions or strategies and to understand the systems' dynamics. Hurrion has conducted experiments to evaluate the effects of visual interactive simulation. In a recent study, an experiment was carried out to determine if the use of known good heuristic methods (such as "First In First Out" and "Least Work Remaining") in various job-shop scheduling problems could be significantly improved with the aid of the interactive capability of a human scheduler. The results suggest that the visual interactive approach can lead to significant improvements in solving job-shop scheduling problems. The learning process associated with watching the models progress and having the ability to change priority rules interactively seems to lead to better management of job-shop scheduling. Hurrion has been developing a simulation language, which he calls VISION (for Visual Interactive SimulatiON), for use in implementing such simulations. This is a discrete event simulation system that allows a user to build a simulation model with dynamic visual output and provision for user interaction at run time.

Dr. Roy Johnston is interested in Bayesian forecasting. This is embodied in a forecasting technique called the Dynamic Linear Model (DLM), which Johnston says includes many conventional methods, such as linear regression, exponential smoothing, and linear time series models as special cases. Use of the DLM may be interactive, allowing information about parameters (such as growth rate, for example) to be updated as circumstances affecting the time series are believed to change. Johnston says this also allows the model to respond effectively in the start-up situation where no prior data history (as distinct from information) is available. This is done by specifying a priori distributions for the parameters of the system and proceeding sequentially through discrete time periods using the Kalman Filter. Two equations are involved in specifying a DLM:

the observation equation, $y_t = F_t\theta_t + v_t$;
$v_t \sim N(0, V_t)$,

the system equation, $\theta_t = G\theta_{t-1} + w_t$;
$w_t \sim N(0, W_t)$,

where

θ_t is the $n \times 1$ vector of (random) parameters at period t,

F_t is a $1 \times n$ vector of independent variables, known at times t,

v_t is random noise, with V_t known at time t

G is an $n \times n$ known system matrix,

w_t is a random normal vector, with W_t known at time t.

If the DLM models the observation series $y_1, y_2 \ldots$, and if the distribution of θ_0 is $N(M_0, C_0)$, then the posterior distribution of θ_t at time t (given the observation $y_1, y_2 \ldots y_t$ and independent variable values $F_1, F_2, \ldots F_t$) is also normally distributed, say $N(M_t, C_t)$. The values of M_t and C_t are obtained recursively with a Kalman Filter. Now for a given value of F_{t+1} forecasts of the expected value of Y_{t+1} can be made.

Johnston showed the author some results of an application of the above methodology to forecasting sales of cider by a well-known producer in the UK. The sales of cider in the UK experienced an upsurge during the hot and dry summers of 1975 and 1976. Apparently, conventional linear growth seasonal forecasting systems were unable to isolate the effects of this exceptional weather, so they tended to generate high forecasts for the ensuing average to poor years for cider comsumption. Further complicating the forecasting problem was a government-imposed excise duty in 1977 that presumably depressed demand still further for a few years. A DLM was developed that included parameters representing growth and seasonality plus the effects of exceptional weather, price, inflation, and the transfer effects of price changes. Johnston says the resulting model has produced very satisfactory forecasts for the cider producer. The model has also been used by the producer to examine various future pricing strategies.

D. R. Barr

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RISK THEORY

Managers of systems involving random demand, such as repair facilities and inventory systems, usually depend on some method of predicting levels of future demands for services or items. Such predictions are made using models of the systems being managed, including the stochastic processes involved. There are a variety of methods the analyst might use to assign such models. For example, to assign probabilities to events of interest in the problem, the analyst might use estimates based on historical data concerning occurrences of the events in the past. Alternatively, the assignment of probabilities might involve mathematical derivations with mathematical models of the stochastic process involved; a third possibility might be to make assignments based on experts' subjective judgments of the likelihood of occurrence.

But all of the above methods involve experience and historical perspective in some way. How might assignments be made in situations where there are few or no data? How can an expert form reasonable intuitions about events that rarely occur? As a particular example, how can actuaries determine rates to be charged for insurance that might require very large settlements on very rare occasions? Finding answers to the latter question has become a research activity of Jozef L. Teugels of the Mathematics Department of the Katholieke Universiteit Leuven, Belgium.

Teugels has a wide range of research interests, all fairly theoretical in nature. He is working on probabilistic methods in numerical analysis, which have applications to numerical integration, and he is also interested in the mathematics of music. During a recent visit to Katholieke Universiteit, the author was told by Teugels that even though music has a smaller dictionary than written language, it is more complicated. For example, according to Teugels, even though harmony is taught in music schools, it is impossible to define. "It is part psychological and part mathematical," he says. Of course, he is interested in the mathematical part and has a PhD student working under his direction who is developing related algebraic theory. Teugels has been working for 10 years on a book on regular variation, along with Nicholas Bingham (Western College, London) and Charles Goldie (Univ. of Sussex, Brighton). ("Its about done," he says.) It will be a theoretical book, connected with complex analysis, differential equations, probability, and statistics. Even though his work is quite mathematical, Teugels insists that it is applied. According to him theory makes sense only if it is backed up by applications.

There are applications of Teugels' work on regular variation to the actuarial problem concerning rare events cited above. Teugels calls this "risk theory". Actuarial science needs the involvement of statisticians, and it appears that members of the European statistical community are becoming involved; several universities are considering establishing chairs in "insurance mathematics", for example. In what follows, we briefly outline some of Teugels' recent results concerning uses of extreme order statistics in making statistical inferences related to occurrences of rare, large outcomes on a random variable. Typically, the distributions used in the models have no variance and often they have no means, so many common analytical methods are not appropriate.

The concepts of regular variation and slowly varying functions have been used extensively in probability theory. A positive function L with domain $(0, \infty)$ is slowly varying (at ∞) provided $L(tx)/L(t) \to 1$ as $t \to \infty$ for every $x>0$. A function U varies regularly with exponent α provided it is of the form $U(x)=x^{-\alpha} L(x)$, where L is slowly varying. It turns out that for any positive monotone function U on $(0, \infty)$ such that $U(tx)/U(t)$ converges, as $+\infty$, on a dense set, the limit function must be of the form $x^{-\alpha}$. Now suppose $X_1, X_2, \ldots, X_n$ is a random sample of a positive population with *CDF* F such that $F(x)<1$ for all x and $1-F$ varies regularly with exponent $\alpha>0$, i.e., $1-F(x)$ is asymptotically of the form $x^{-\alpha} L^{-\alpha}(x)$ where $L^{-\alpha}$ is slowly varying. Let $X(1), \ldots X(n)$ denote the order statistics. Then there exist scale factors a_n such that $x(n)/a_n$ has a limiting distribution G not concentrated at 0, and this limiting distribution must be of the form $G(x)=exp(-cx^{-\alpha})$ for $x>0$. This gives some hint of the role of regular variation in asymptotic theory associated

with extreme order statistics. Distributions on $[0,\infty)$ for which

$$1-F(x) \sim x^{-\alpha} L^{-\alpha}(x), \quad \alpha>0, \qquad (1)$$

where L (and hence $L^{-\alpha}$) is slowly varying, are said to be Pareto type.

A significant statistical problem for Pareto-type distributions is point or interval estimation of α. Teugels has obtained results that involve the use of extreme order statistics to make inferences about α; this seems reasonable, as (1) is an asymptotic expression for $x\to\infty$. For example, he has considered in some detail the asymptotic distribution of a "cross ratio" of four large order statistics,

$$T_n(k,\lambda,\mu,\nu) = \frac{X(n-k+1)}{X(n-\lambda+1)} \cdot \frac{X(n-\nu+1)}{X(n-\mu+1)}$$

where $1<k<\lambda<\mu<\nu$ are fixed. He has obtained the asymptotic distribution of T_n when F satisfies (1), and he has obtained limiting (as $n\to\infty$) values of $\alpha\, E[\log T_n]$ and $\alpha^2\, V[\log T_n]$. The results show how $\log T_n$ can be used to get an asymptotically unbiased point estimation for α^{-1} for each quadruple (k,λ,μ,ν).

A result that can be used to obtain asymptotic confidence intervals for α is as follows. Suppose F satisfies (1) and assume L is normalized in the sense that

$$L(x)=c\ exp \int_1^x \frac{\varepsilon(u)}{u}\, du \qquad (2)$$

where $c>0$ and $\varepsilon(u)\to 0$ as $u\to\infty$. Let $\{c_n\}$ be such that $1-F(c_n)=k/n$ and let $n\to\infty$, $d_n=c_n/\sqrt{k}$. Then

$$[X(n-k+1) - c_n]/d_n \xrightarrow{D} N(0,\alpha^{-1})$$

as $n\to\infty$, $k\to\infty$. As an example, suppose $F(x)=exp(-x^{-\alpha})$ a well-known extreme value distribution. This distribution is Pareto type with a slowly varying L that satisfies (2). Now if $k=o(n^{2/3})$, then

$$\sqrt{k}[\alpha\ log\ X\ (n-k+1) - log\ (n/k)] \xrightarrow{D} N(0,1),$$

which gives an asymptotic confidence interval for α.

Finally, we quote a joint limit theorem obtained by Teugel for two order statistics. Suppose F satisfies (1) where L satisfies (2). Define $1-F(b_k)=k/n$ and $\alpha\, d_k=b_k/\sqrt{k}$. Assume $k\to\infty$, $m\to\infty$, $k/n\to 0$, $m/n\to 0$ and $k/m\to\theta$. Then

$$\frac{X(n-m-k+1)-b_{m+k}}{d_{m+k}}, \frac{X(n-k+1)-b_k}{d_k} \xrightarrow{D} N(\underline{0}, \Sigma),$$

where the variances in Σ are 1's and the covariance is $\sqrt{\theta/(1+\theta)}$.

D. R. Barr

ONR London

OCEAN SCIENCES

THE UK MARINE BIOLOGICAL ASSOCIATION LABORATORY

During a recent visit to the Plymouth Laboratory of the UK Marine Biological Association, the author was hosted by Dr. E.J. Denton, the director, and Mr. George Best. The laboratory is a long-established private research facility, although most of the funding comes from the Natural Environmental Research Council. Some support comes as contract money from mission-oriented agencies such as the Department of Environment, but attempts are made to hold such support to a minimum (20% of total). Oversight of the laboratory is by a council, with a laboratory director as secretary, that includes a representative of the Royal Society, university professors, and various noted scientists. The laboratory has a permanent staff of approximately 100, of whom 25 are scientists. At any one time there are 15 to 20 visiting scientists, and the total during a year may number nearly 200.

Throughout the visit, the point was made repeatedly that the main interests of the laboratory are in the area of physiology. For example, the work of Best (and of C. Nichol, the former director), on Chaetopteris, of Q. Bone on pelagic tunicates, and of J. Thorne on Pholas, is extremely well instrumented by several old electron microscopes and two new Japanese scopes capable of X-ray spectral scanning. There is much activity in electrophysiology of marine organisms, and electronics support is good. There is also significant interest in bioluminescence and related effects.

Denton is currently devoting his attention to hearing and sound communication in herring and sprat. This aspect is not discussed in detail here because it is not central to bioluminescence, but much good physics is involved, and Denton and his coworkers have done some beautiful physiological research. This leads naturally to consideration of sound in the sea and the role played by air bubbles (generated by wave action and dragged down, or emitted by fish directly). Recent work by Denton, some of it in collaboration with Dr. Peter Herring (Inst. of Oceanographic Science, Wormley, UK), concerns the spectral and angular distribution of light emitted from certain mesopelagic fish. The research has included studies of the spectral distribution of light emitted and the resulting spectral and angular distribution after the light has passed through the filter system of the photophore. The initial emission and filter absorption differ in different species, but the final light emerging matches that of daylight found where the fish live at depths of approximately 200 m at night and 600 to 700 m in daytime. The angular distribution is nearly cosine squared. Work has also been done with Herring on Pachysthomious ("red eye"). The fish has a red reflector behind the

eye, red and green patches under the eye, and a ventral area that emits blue light. The red (which extends beyond 6200 A) is presumably used for signaling and the blue (which matches ambient light) for camouflage. Similar work has been done on squid and crustaceans.

Ms. J. Thorne (a visiting PhD student from London Univ.) is studying a bioluminescent rock borer, Pholas dactylis. Her main interest is in the physiology of the luminescent organs; she is collaborating with A.K. Campbell (Univ. of Wales, Cardiff) who is studying the luminescence phenomenon. Pholas is a bivalve mollusk that somewhat resembles a common mussel. It bores into rocks to a depth of more than a foot and extends a siphon to within about 3 in. of the rock surface to feed. When disturbed, it squirts out water, retracts, and in the process, presumably, luminesces. It normally lives in sandstone, chalk, and possibly clay or shale at the lower shoreline and a little beyond, so that it is exposed only at extreme spring tides. Thorne and Campbell have not yet seen in situ luminescence and do not know what stimuli excite it in nature except direct contact of the siphon. It appears that the luciferin and luciferase may exist in different cells, that the luminescence results in a mixing process external to the organism, and that it might make a trail. The physiology is being studied at Plymouth; the luminescence work will be done mainly at Cardiff. The motivation for the work, which is in an early stage, is complex. There is interest in the luminescence phenomenon for its own sake, but to attract support from the Medical Reseach Council, initial studies are directed toward finding out whether the purified luciferin will provide a better assay technique than luminol in the redox studies Campbell is conducting. The work of Campbell relates to studying the role of polymorphonucleo-leucocytes ("polymorphs") in research on rheumatoid arthritis. If Pholas dactylis does provide a superior substrate for the assay, a new problem arises. Pholas is an endangered species and if a commercial company moved in on a large scale, it would be wiped out. Therefore, along with the efforts to study and purify the luciferin (the luciferase is less specific) there will also be efforts to learn to synthesize or culture the material. In the meantime, an interesting bioluminscent species is being studied. Studies of stimuli required to excite luminescence, the spectral distribution, spatial characteristics, and duration of light would be of interest.

Dr. M.R. Clarke has worked with Herring on the luminescence of Sepiola atlantica, a squid, and Spirula spirula, a mollusk. In the case of S. atlantica, the luminescence is due to symbiotic bacteria, which may be pushed out by stimuli. K.H. Nealson (Scripps Inst. of Oceanography, La Jolla, California) participated in the identification of these bacteria. In the case of S. spirula, there are no bacteria, and the light organ has been studied. The luminescence seems to be long lived and may be steady over long periods. Some animals could be stimulated by handling to increase intensity by factors of 5 to 10 over a period of 1 to 5 sec before returning to base level in 30 to 60 sec. The work is another indication that even though primary interest may be in physiology, much bioluminescent phenomenological information can result from the research.

Another aspect of Clarke's work is related to a practical problem associated with specimen collecting. There is evidence that nets being towed do not come close to sampling the marine life in the region they sweep through, either in kind or in number. One hypothesis is that the nets become bioluminescent (which has been observed) and thus frighten away many animals before reaching them. There is thus a very practical reason to learn how to inhibit bioluminescence, and laboratory and field experiments with net systems are being planned.

Clarke and Dr. Quentin Bone are interested in methods of stimulating bioluminescence in real environmental situations and are contemplating studies of Xenodermichthys sp., found at depths of 400 to 500 m in the North Atlantic. They are considering stimuli of light (function of intensity and wave length), pressure (function of intensity and frequency), and the possible use of piezoelectric transducers.

Campbell is working with Bone, whose interest is in pelagic tunicates, on the ultrastructure and activation of Obelia sp. In work with Pyrosoma sp. the luminescence appears to be caused by bacterialike objects in the light organ. The observed relation between luminescing and cilia arrest has led to investigation of the possible role of calcium ion as the direct cause of light emission by the bacteria.

Calcium ion release is also under investigation in the Obelia studies. Bone's experiments have led him to think that the hydroid is not well suited for studying the propagation of signals, and so he is using the free-living medusae. The signals appear to be propagated not only along the nervous system but also across sheets of epithelia. As with other studies at Plymouth, these are replete with beautiful electron microscope records, in this case of the luminescent cells. There is preliminary evidence that the luminescent flash may be delayed on the order of 10 msec after the electrical signal reaches the cell. One hypothesis is that the flash is directly caused by transport of calcium ion from the surrounding medium into the cell.

Additional calcium ion studies are under way on the heliozoan Actinocoryne. The element studied is a rod (of microtubules) approximately 200 μm long and 10 μm in diameter with a top of extended arms. Upon stimulation, a calcium action potential develops (demonstrated by lowering external calcium or blocking with manganese or cobalt. Some 2 to 3 msec later the rod contracts and then slowly rebuilds.

Throughout the visit, the author had the distinct impression that the laboratory is a

well-equipped, busy, and productive facility doing good work on interesting and important problems.

G. T. Reynolds

Princeton University, NJ

NEWS AND NOTES

ECONOMETRIC MODELS AND LEGISLATORS

Large econometric models operate in all the developed countries; they are often useful in predicting things like the level of manufactured exports or the effects of changes in commodity prices or exchange rates on industrial investment. The models are originated, updated, and run by specialists. Sometimes there are hundreds of equations in the model, and even with such complexity, there are always important residuals or "unexplainables" that remain, so the operators are often tinkering with the model and trying to improve it.

The outputs of such models often influence technical and bureaucratic decisions, but they seldom excite the interest of the public. Nor do legislators often get directly involved with the model domain. Recently in Britain, however, the "Treasury model," which is one of the more famous econometric models in the world, has been the subject of considerable political attention. The reason is that the explicit policy of the Thatcher government has been to avoid "reflating" the economy by pouring government money into industrial and service projects; such reflation, the conservative argument goes, would cause further inflation. A few months ago, Britain's Trades Union Congress (TUC), the central labor organization, challenged the government to run the Treasury model under different levels of government public investment and under different (reduced) levels of Value Added Tax (VAT). The results have been widely discussed in Parliament and in the British press.

From the model runs, it appeared that higher public spending should indeed produce more inflation, that reduced VAT would do the same within 3 years, and that the output boost from government money would be temporary and would dry up within 4 or 5 years. Another simulation that led to more positive consequences was based on lower wage inflation. Even a 2% drop in wages is predicted to produce drops in unemployment, and the temporary reduction in living standards is recovered after a couple of years.

Perhaps these specific simulation results are less important than the fact that the UK Treasury model is receiving much more direct political attention. Some of the findings are very important. For instance, the model shows clearly the devastating effects of wage inflation on the economy, and regardless of political traditions, all groups will have to come to terms with this relationship. And as legislators and the general public hear more about such large models, there will be pressure on the people producing and running them to improve their accuracy and their usefulness.

Nicholas A. Bond, Jr.

ONR London

LASER LABELING

Many products have to be marked with a "use before...." label. Laser Applications, in Hull, England, has marketed a system for labeling foods and then materials with laser pulses. A stencil is prepared with the required mark, and a brief laser pulse burns off a thin layer of the top material, leaving an indelible mark.

The key stimulus for the Laser Applications product was an EEC consumer's regulation. Starting next January, all EEC food products with projected shelf life of less than a year must be marked with a date, and this requirement has generated a small boom in marking systems.

Laser markers have often been proposed for personal security labeling, but no systems are in wide use. The food-marking stimulus should accelerate the introduction of computerized marking systems generally.

Nicholas A. Bond, Jr.

ONR London

CASH COMPENSATION FOR CRIMINAL ASSAULT

How much should an assault victim receive as compensation for having two front teeth knocked out? For being raped? For being blinded? These are obviously difficult questions, and few people would agree on the exact amount of damage. But the British Criminal Injuries Board has been trying to establish some standard money payments for various assault offenses as a guide to courts and boards. The highest recommended value is £45,000 (about 86,000 dollars US) for assault-induced blindness; loss of one eye is scaled at £10,000, two front teeth at £1,000, and a broken jaw at £1,200. Presumably as a result of inflation and other factors, the board raises its basic damage rates from time to time and has just revised the old 1979 money payments schedule.

Perhaps the most controversial compensatory award figure is the £2,250 ($4,300) figure set for rape; this compensation is about half the £4,000 pounds a man would receive for a badly scarred face as a result of an attack. While the values proposed by the board are not awarded automatically, they are used in Britain

as a starting point for assessing damages; in a trial or hearing, special circumstances can be argued that might raise or lower the amount of compensation.

Personal compensation to the survjving families of airline crash victims varies widely from one country to another. In some European countries, more or less standard money figures of "worth" are set; a typical death payment from the airline may be on the order of 50 to 100 thousand US dollars, and in some countries the offer will be much less. American practice, as in the 1978 San Diego PSA disaster, may scale the family settlement according to the expected remaining lifetime income of each victim; this usually results in far more generous compensation. At least one European decision-analysis group is working on the relative (negative) utility of different injuries; it will be interesting to see how the values obtained agree with the findings of official bodies like the Criminal Injuries Board.

Nicholas A. Bond, Jr.

ONR London

AUTOMATIC INSULIN INJECTOR

Projects in several countries have explored the possibility of building a device that would inject insulin into diabetic patients. One promising design comes from Belfast, Northern Ireland. Early versions of the device reportedly can deliver several hundred small shots of insulin per day. According to the developer, Kenneth McMullen of Mater Hospital in Belfast, the package is not much bigger than a wristwatch; an important part of his work was producing a special insulin solution that could be injected in tiny amounts without sludging or gumming. Development of the control circuitry was done under the direction of Colin Tindal at the Mechanical Engineering Department, Queen's University, Belfast. Almost certainly future versions will be adaptive to individual variances in drug response and will deliver a series of injections that is more optimal than any fixed treatment schedule could be.

Nicholas A. Bond, Jr.

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ONR CONSPONSORED CONFERENCES

ONR London can nonimate two registration-free participants in the conferences it supports. Readers who are interested in such participation should contact the Chief Scientist, ONR London, as soon as possible.

Conference on Optical Techniques in Magnetic Resonance, Hull, UK, 31 March - 2 April 1982.

International Meeting on Lithium Batteries, Rome, Italy, 27-29 April 1982.

Symposium on Coastal Problems in the Mediterranean, Venice, Italy, 10-14 May 1982.

International Meeting on Analysis of Sample Survey Data & Sequential Analysis, Jerusalem, Israel, 14-18 June 1982.

NATO ASI on Numerical Taxonomy, Bad Windsheim, FRG, 4-16 July 1982.

1st Biennial National Atomic Spectroscopy Symposium, Sheffield, UK, 13-15 July 1982.

International Conference on Practical Bayesian Statistics, Cambridge, UK, 21-24 July 1982.

IXth IUPAC Symposium on Photochemistry, Univ. of Pau, France, 25-31 July 1982.

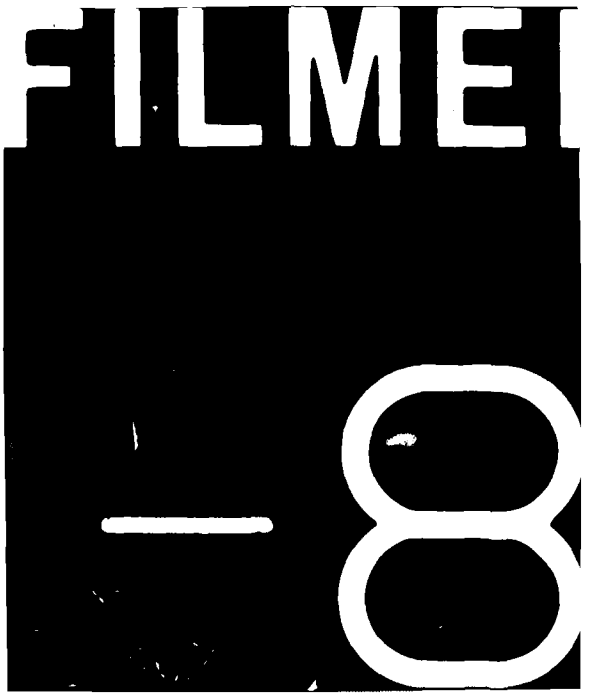
XI International Symposium on Mathematical Programming, Bonn, FRG, 23-27 August 1982.

4th Europhysical Topical Conference on Lattice Defects in Ionic Crystals, Dublin, Ireland, 30 August - 3 September 1982.

14th Europhysics Conference on Macromolecular Physics, "Polymer Crystals: Structure & Morphology," Vilafranca del Penedes, Spain, 21-24 September 1982.

EUROPEAN VISITORS TO THE US SUPPORTED BY ONR LONDON

Visitor	Affiliation	Navy Lab./Org. to be Visited
Dr. J.B. Abbiss	RAE Farnborough, UK	NRL, NSWC, USNA (20-21 April 1982)
Dr. L. Bengtsson	ECMWF, Reading, Berks,	NEPRF, Monterey (June or July 1982)
Dr. J.C. Bennett	Dept. of Electronics and Elec. Engr., Univ. of Sheffield, UK	NOSC, San Diego (March or April 1982)
Dr. J. Cousins	Propellants, Explosives, and Rocket Motor Establishment, Westcott, Aylesbury, UK	NWC, China Lake,(1 July 1982) US Navy Consultant, Inst. of Technology, Pasadena, CA, (28 June 1982)
Dr. C. Leijnse	Industrial Acrodynamics, Aerospace Lab., Amsterdam, The Netherlands	NAVAIR (11 May 1982) NTEC, Orlando, FL (13 May 1982)
Dr. John Nelder	Rothamsted Experimental Station, Harpenden, Herts, UK	ONR (4 May 1982)
Dr. C. Ranz & Dra. A. Soler	Instituto de Acustica, Madrid, Spain	ONR, NRL, NUSC or NORDA (19-22 April 1982)
Dr. W.J. Stronge	Univ. Engn. Dept., Cambridge, UK	NRL NWC, China Lake NPS, Monterey (Late June or early July)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